Space Weather Technical Forecast

Issued on Tuesday, 08 March 2022 at 12:44 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight Chance of G1 Minor Geomagnetic Storms, peaking to end current working week. Daily Chance of R1 Minor Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the period, with activity confined to occasional low C-class. The peak events of the period were both attributable to a bright flux region near or possibly just over the northeastern limb, likely implying that there is a sunspot at this location - to be confirmed in forthcoming imagery. The disc was otherwise populated by up to six sunspot groups. Of these, AR2960 in the southeast dominated in terms of magnetic complexity and area, showing slight intermediate spot proliferation and areal increase to reach Ehi/Beta-Gamma. Also of note was the newly-numbered AR2964 in the southwest, with this group reaching Dsi/Beta from a starting point of an unremarkable plage 24 hours ago. Remaining spots on the disc were less significant, with 2962 and 2957 suffering a decrease in spot count and area as well as latitudinal spreading, while 2963 and 2961 also showed fading trends, the latter to the point of becoming plage by the end of the 24 hours.

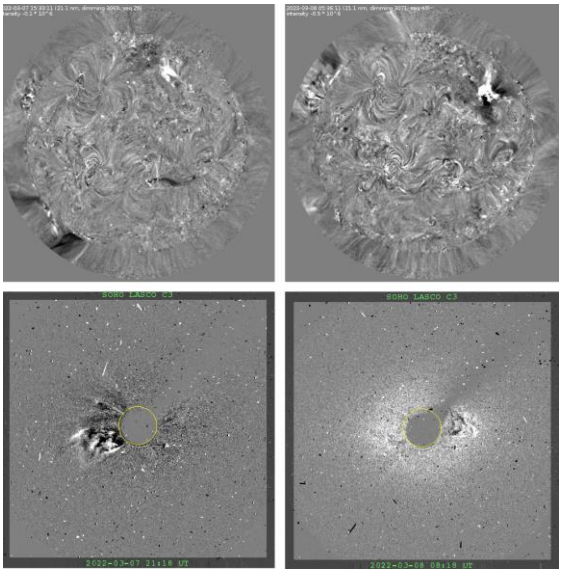

Figure 0: Time-integrated view of 07/1400UTC prominence and 08/0400UTC filament eruptions in AIA-211 (processing courtesy of ROB SIDC). Also shown below are Lasco C3 running difference images of the CMEs. The later of these events has yet to be analysed; the former misses Earth.

There were two main events visible on coronagraphs in the 24 hours: firstly a large prominence eruption from the southeastern quadrant around 07/1400UTC; and secondly a large filament eruption from the northwest disc around 08/0400UTC, from near the plage containing now-faded

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Ex-2958. The former has been analysed and found to be comfortably behind the Earth in the track of its orbit to no effect. The latter is pending assessment, but is provisionally more likely to carry at least some form of Earth-bound component for being more central. Updates will follow regarding this final aspect. The disc is otherwise populated with numerous sunspot regions and filaments at present, and there is ongoing risk of further similar emissions.

Solar Wind / Geomagnetic Activity: The solar wind was characteristic of a waning connection to a negative polarity high speed stream, probably that from CH61/- and 62/-. The phi angle was accordingly mostly negative (towards the sun), but with the central third of the period punctuated by forays into a positive sector. The solar wind speed, as measured by DSCOVR at L1, showed a somewhat erratic tendency but fell overall in the 24 hours, from the low 500s of km/s to around 425km/s. the corresponding density was variable within normal background levels (single figures ppcc), while the IMF was at or below 6nT. The north-south component was initially mostly anti-aligned with Earth's field near -5nT, but became more neutral with time, with a northward deflection otherwise peaking at +4nT.

The net result of the above solar wind measures was provisionally increasingly Quiet Kp indices, from an early peak of 3+ in the 12-15UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2 MeV) was mainly High, with a peak value of 10.2kpfu at 07/1520UTC, although the diurnal rise during the current UTC day has been more muted. The corresponding 24-hour integrated electron fluence remained above the Active level with an initial increase followed by a gradual ebbing trend. The 08/0000 UTC observation was 3.48e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low, with further occasional C-class flares and a daily Chance of Moderate activity, with AR2960 the main culprit.

Solar Wind / Geomagnetic Activity: There are currently two low confidence CMEs in the forecast and a third undergoing analysis. This part of the forecast is considered with the current waning fast solar wind from CH61/62. All considered, the effects of both the persistent and transient solar wind should give initial Quiet conditions, followed by an increasing chance of G1 after midweek, peaking at a daily Slight Chance before waning before the UTC weekend.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, albeit with a very slight and increasing daily risk of S1. The high energy electron flux is expected to persist at High levels but with a chance of drop-out from any of the CME arrivals. The associated 24-hour fluence is expected to remain Active through the period, but with increased uncertainty towards the end of the period due to the potential CMEs.

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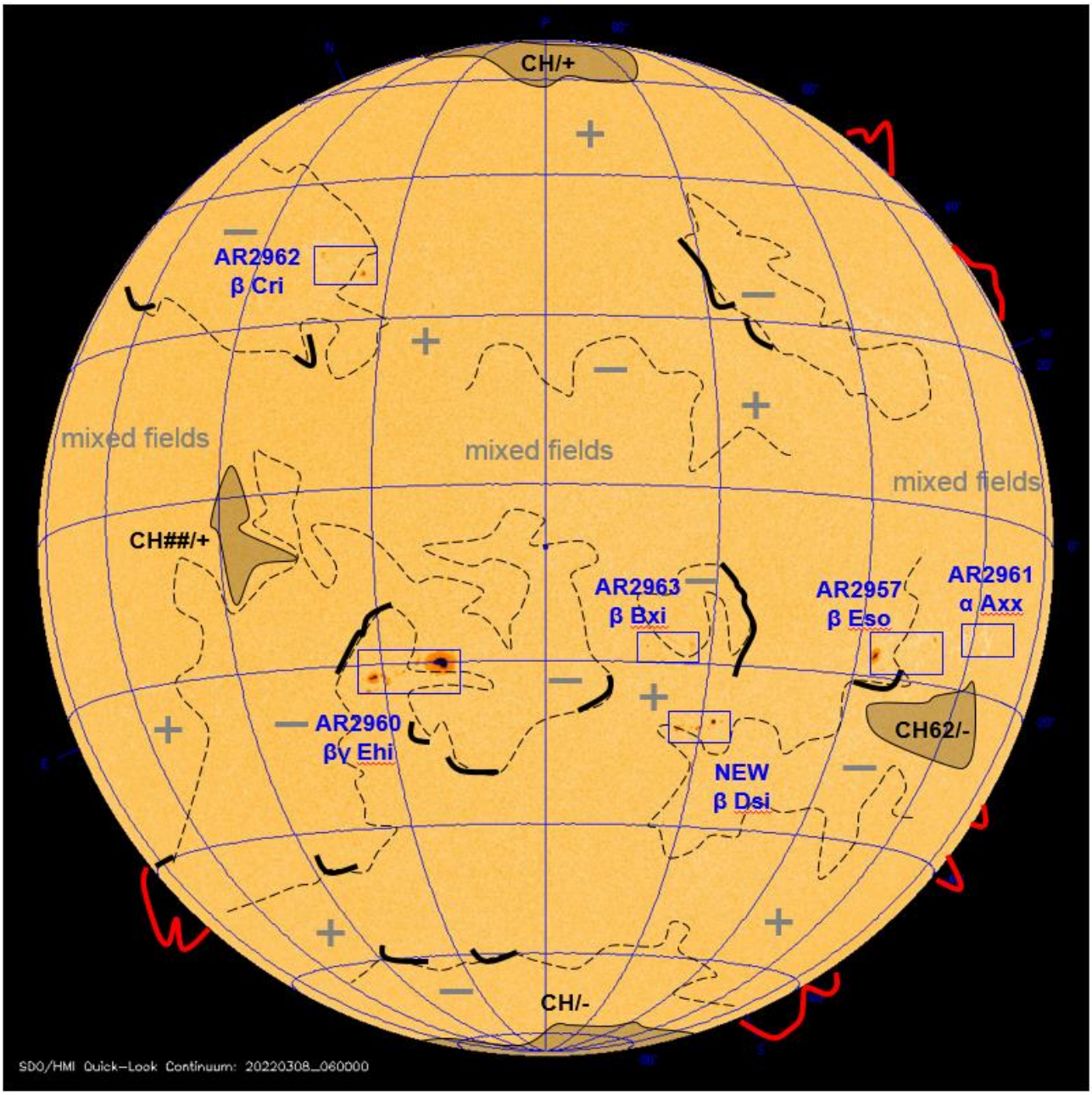
Figure 1. Solar Analysis Valid 08/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two main components to the forecast.

Firstly, the current fast wind regime is expected to gradually ease away through the remainder of day one (Tuesday 08 March), with no further notable coronal hole source enhancements expected.

Secondly, the transient forecast is much more complex and of much lower confidence. At the time of writing, there are two potentially Earth-directed CMEs in the forecast outlined in the following two paragraphs. There is also one event observed just before 08/0400UTC from the sun's northwest awaiting imagery for assessment - this does not yet feature.

The first of the possible CMEs in the forecast is of very low confidence due to its source being uncertain and inferred from coronagraphs - a weak CME was observed early on 05 March, heading northeast on SOHO Lasco and northwest on STEREO A COR2, suggesting a possible component in the Earth sector. This would bring a weak CME arrival to end day two (09 March) into day three (Thursday 10 March).

The second CME in the forecast is a filament eruption from the vicinity of Ex-2958 in the northwest quadrant around 06/2245UTC. The subsequent CME is a partial halo on Lasco imagery, and gives a glancing arrival late on day three (Thursday 10 March) or early day four (11 March).

All considered, the effects of both the persistent and transient solar wind should give initial Quiet conditions, followed by an increasing chance of G1 after midweek, peaking at a Daily Slight Chance before waning before the UTC weekend. As stated, there is one CME pending assessment that may alter this outlook.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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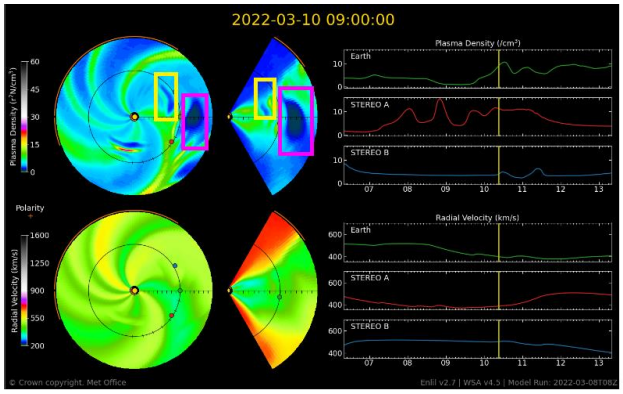
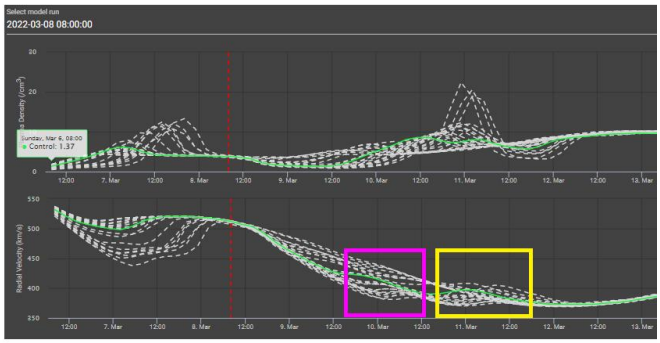
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0650	Partial	Unknown	N04E15	224km/s	After 09/2100UTC	Very low confidence, with uncertain source.
07/0920	Partial	Ex-2958	N10W24	417km/s	10/2100UTC	Good confidence, but only glancing impact likely.

Figure 2: Latest MOSWOC Enlil run and ensemble. The two potential Eearth-bound CMEs are shown boxed in magenta and yellow, with the simulation paused between the two events for clarity at 10/0900UTC (left image). Also shown is the earlier 02 March CME that influence the Ensemble traces through 06 and 07 March – this is now dropped from the forecast.





Radio Blackouts - X-Ray Flares:

Both of the sunspot regions that are contributing most significantly to the daily chances of X-ray flares are expected to remain on the Earth-facing side in the period, these being AR2960, an Ehi/Beta-Gamma, and also the newly-numbered AR2964 that has rapidly developed in the past day to reach Dsi/Beta.

Far side soundings and EUV imagery from STEREO suggest there may be some northern hemisphere returning regions of note into the weekend, although the contribution of these is not yet considered.

All in, a flat daily Chance of M-class flares is suggested, revised downwards from raw probabilities of such past regions given the observed lack of activity.

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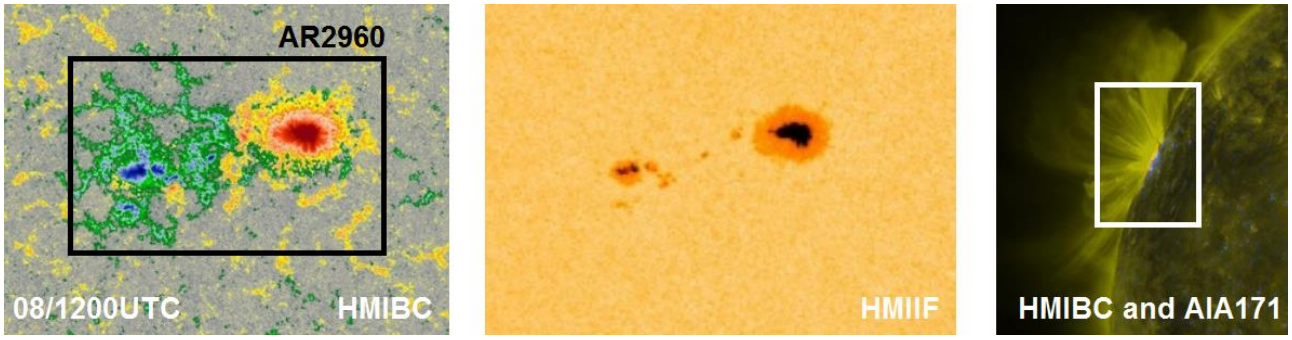
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Magnetic and visible imagery of AR2960 and a forthcoming potential spot group on the northeastern horizon.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES 16 is currently at Background levels. The raw probabilities for S1 or above suggest a very low but 'measurable' risk at present, which should increase through the four days - mainly the result of AR2960's Ehi Beta-Gamma classification and limb-ward advance.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	2	2	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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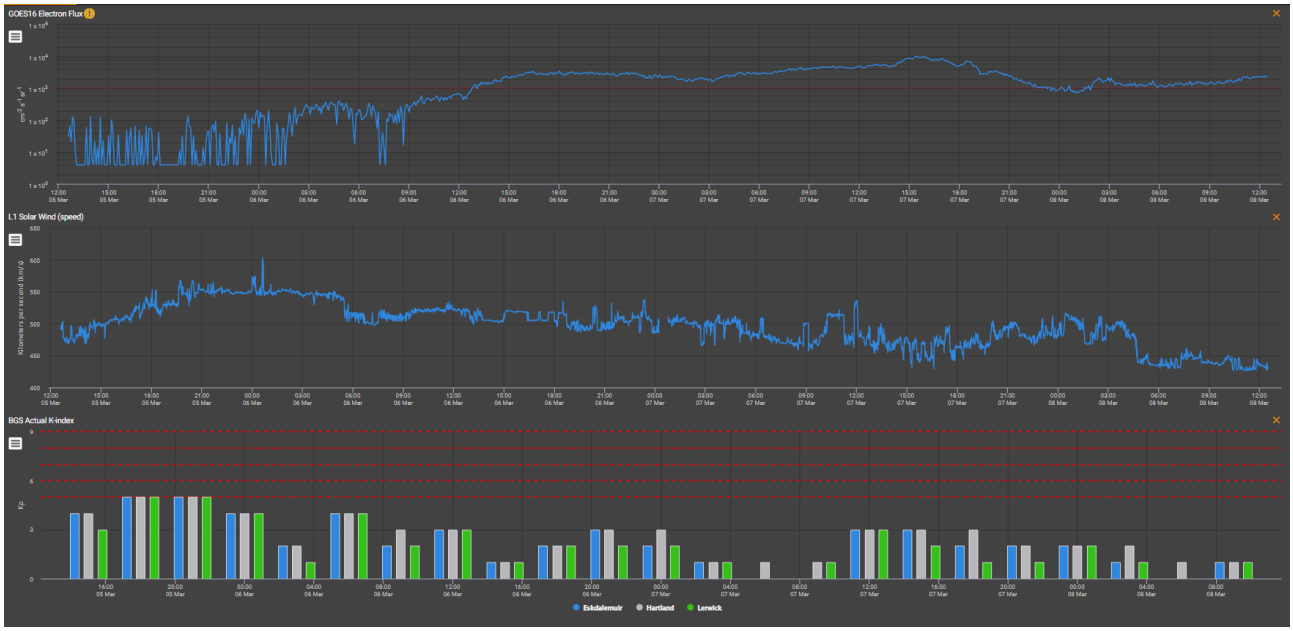
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 is currently mainly High, due to the recent fast wind enhancements. These flux levels are expected to persist for much of the period, but could see brief dropouts from any glancing CME arrivals after midweek, although it should be noted that these arrivals are low confidence, particularly earlier in the four days.

The associated 24-hour fluence is forecast to be Active (greater than 1e8 integrated pfu) for much of the period, but again with an increasing chance of falling below after midweek UTC.
With transients now dominating the forecast, REFM is not considered to be a useful source of information, although it does serve to highlight the expected waning trend should all the current forecast CMEs miss.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	80	70	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: The past three days in GOES 16 high energy electrons; L1 solar wind speed; and UK magnetometers. The current diurnal oscialltion ought to now be maintained in the near-term, with confidence reducing given successive CMEs.



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